**DEPARTMENT OF MECHANICAL ENGINEERING**

**SET, IIMTU**

**SYLLABUS FOR PhD ENTRANCE EXAM.**

1. **Fluid Mechanics and Thermal Sciences:**

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration: differential equations of continuity and momentum: Bernoulli's equation; viscous flow of

Incompressible fluids; boundary layer; elementary turbulent flow: flow through pipes, head losses in pipes, bends etc. Heat Transfer: Modes of heat transfer, one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction. fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes: thermal boundary layer: effect of turbulence: radiative heat transfer, black and grey surfaces, shape factors, network analysis: heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics: thermodynamic system and processes; Carnot cycle. Irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion.

1. **Manufacturing Sciences:**

Engineering Materials: Heat treatment; stress strain diagrams for engineering materials. Metal Casting and Joining Processes: Solidification and cooling in casting; riser and gating design; casting design considerations; physics of welding; solidification and cooling in welding. Forming: Plastic deformation and yield criteria; load estimation for bulk (forging, rolling, and drawing) and sheet (shearing, deep drawing, and bending) metal forming processes. Machining: Mechanics of machining; single and multi-point cutting tools; tool geometry and materials; tool life and wear; principles of non-traditional machining processes (USM, ECM, EDM, JM). Metrology and Inspection: Limits, fits and

tolerances; alignment and testing methods; tolerance analysis in manufacturing andassembly.

1. **Robotics and Automation:**

Kinematics and dynamics of particles and of rigidbodies in 2D; Free and forced vibrations. Types of Robots, spatial transformations and kinematics of open chain linkages, dynamics, singularity and workspace analysis, basic robot control, programming in VAL Il, trajectory planning, industrial automation.

1. **Solid Mechanics and Design:**

Free body diagrams and equilibrium; Kinematics and dynamics of particles and of rigid bodies in 2D; Free and forced vibrations of single degree of freedom systems (undamped and damped); Resonance; Stress and strain; Hooke's law; Mohr's circle for plane stress and plane strain; Shear force and bending moment diagrams; Bending and shear stresses; Thin cylinders; Deflection of beams; Failure theories.

1. **Nano and Micromachining**

Introduction: Introduction, Basic elements of molecular dynamics modelling, Design and requirements for state‐of‐the‐art MD cutting process simulations, Capabilities of MD for nanoscale material removal process analysis, Advances and recent developments in material removal process simulation, Summary. Ductile Mode Cutting of Brittle Materials The mechanism of ductile mode cutting of brittle materials, The chip formation in cutting of brittle materials, Machined surfaces in relation to chip formation mode Diamond Tools in Micromachining Diamond technology, Preparation of substrate, Modified HFCVD process, Nucleation and diamond growth, Deposition on complex substrates, Diamond micromachining. 2 Conventional Processes: Micro-turning, Micro-drilling and Micro-milling Introduction, Micro-turning, Micro-drilling, Micro-milling, Product quality in micromachining Micro-grinding and Ultra‐precision Processes Introduction, Micro and nanogrinding, Nanogrinding tools 3 Non‐Conventional Processes: Laser Micromachining Introduction, Fundamentals of lasers, Laser microfabrication, Laser nanofabrication. Evaluation of Subsurface Damage in Nano and Micromachining Destructive evaluation technologies, Non‐destructive evaluation technologies 4 Micro and Nano Finishing Processes Need for Nano finishing, Magnetic abrasive Finishing, Magnetorheological Finish, Elastic Emission Finishing, Magnetic Float Polishing, Ion Beam finishing. 5 Micro Joining Challenges, Micro Resistance welding, Ultrasonic welding, Micro TIG, Applications. 6 Applications of Nano and Micromachining in Industry Typical machining methods, Applications in optical manufacturing, Semiconductor and electronics related applications.